

Project Description

1. List of Senior Investigators

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2. Achievements under Prior NSF Support

NSF support has played a critical role in making possible the growth and influence of the Institute for Complex Adaptive Matter (ICAM), the parent institution of the proposed International Institute for Complex Adaptive Matter (**I²CAM**). ICAM was established in March, 1999, and became, in April, 2002, a Multidisciplinary Research Program of the University of California. ICAM is an open distributed experiment-driven multi-institutional partnership, whose scientific agenda is to identify major new research themes in complex adaptive matter, and to nucleate and conduct collaborative research and scientific training that draws from the chemical, physical and biological viewpoint on these themes. These goals have attracted leading members of the national materials research community to participate in ICAM activities; at present, there are 13 members of the National Academy of Science and one Nobel laureate on the ICAM Board of Governors and Science Steering Committees.

With a scientific focus on correlated matter, biological physics, and the design of new materials, ICAM seeks to build bridges between the physical and biological sciences, the hard and soft matter communities, and between institutions. ICAM has demonstrated outstanding convening power as it put in place an integrated program of exploratory workshops, fellowships, research and educational networks, and a well-developed communication, governance and advisory structure for its present seventeen US branches: Boston College, Boston University, UC Davis, UC Irvine, UC Riverside, UC San Diego, University of Chicago, Florida State University, University of Illinois at Urbana-Champaign, Iowa State University, Kent State University, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Penn State University, Princeton University, Rutgers University, Sandia National Laboratory. As a significant first step toward developing an international materials research network, ICAM has established a branch at Cambridge University and branch Consortia in Dresden, Karlsruhe, and Paris that represent thirteen additional institutions. Thanks to the willingness of leading individuals and institutions throughout the world to share in the responsibility for organizing workshops and nurturing and supporting the research collaborations that arise from these, it has been able to accomplish this with the remarkably small permanent staff of a half-time director and a half-time administrative assistant.

ICAM's European branches (Cambridge University, Consortia in Paris, Dresden, and Karlsruhe), and its affiliates (the Erice Solid State School and the Lausanne Institute for the Physics of Complex Matter) constitute a significant ICAM and **I²CAM** resource. They bring valuable experience in organizing summer schools and year-round workshops, and in forming Europe-wide research

networks to study frontier problems in correlated matter and biological physics. Moreover all possess research groups that collaborate actively with their US counterparts

ICAM developed a dynamic format for attracting and reviewing proposals for its exploratory workshops that has enabled these to focus on emerging rather than established research themes, with participants (more than half from non-ICAM institutions attending an ICAM workshop for the first time) drawn from a wide range of disciplines and institutions, and a very short lead time (as little as six months) from proposal to implementation. ICAM's fifteen workshop topics have ranged from "Quantum Criticality in Condensed Matter" and "Energy Landscapes and Drug Design" to "Frustration Physics: from Pyrochlores to Biomolecules" and "The Physics of Neural Tissue". Its over three hundred workshop alumni represent a total of more than 80 US and 40 European institutions and provide proof of concept for ICAM's goal of building bridges between institutions and between the physical and biological science communities, while using workshops as a magnet to attract new individuals, institutions, and branches into the ICAM community. ICAM's institutional memory, workshop web sites, and support for nascent collaborations that arise from its workshops, have made possible effective follow-on activities, while giving rise to over twenty publications, a number of which have had a significant continuing impact.

One forthcoming ICAM workshop, "The Evolution of Quantum effects from the Nano-to-the Macroscale" deserves special mention, because it will serve as a prototype for future **I²CAM** workshops. With a joint US/Canadian/European organizing committee (Katherine Le Hur, Sherbrooke, A. Kapitulnik, Stanford, Dirk Morr, UI Chicago, and Catherine Pepin, Saclay) it will be held from May 24-28, 2004 in Cargèse (France) and will be jointly supported by ICAM and the Institute for Theoretical Physics in Cargèse.

ICAM has established a Fellow program that will serve as the prototype for the **I²CAM** Fellow program. It knits together its branches by providing supplementary support to postdoctoral fellows who initiate and conduct research collaborations involving two or more ICAM branches.

ICAM has received seed support for its Emergent Matter Project that seeks to convey the excitement and challenge of identifying and understanding emergent behavior in matter to students of all ages and to the general public by assembling a library of excellent popular talks, preparing a video, developing virtual and physical museum-quality exhibits on "Emergent Behavior in Matter", and paving the way for future documentaries on emergent matter.

Significant international collaborations have come about as a result of Imam's exploratory workshops. A 2002 workshop on "International Collaboration in High Throughput X-Ray Determination" was explicitly designed to enhance collaboration in this important field; representative examples of other ICAM-inspired international collaborations include:

- Formal and informal collaborations on elemental plutonium, a metal with a number of anomalous properties arising from the fact that it has electrons whose states are complex and notoriously difficult to predict using traditional band structure methods because they are a consequence of a competition between atomic (localized) and band (itinerant) tendencies. In July 2001, ICAM sponsored a workshop at Los Alamos National Laboratory that brought together, for the first time, an international group of researchers well-versed in the traditional techniques with theorists from Rutgers University who had developed a method that enable these two tendencies to be treated on the same footing. The consequences were remarkable. A number of formal and informal international collaborations grew out of the workshop.

These involve scientists at Uppsala, Ecole Normale (Paris), Daresbury (UK), Dresden, Rutgers, Aarhus, Prague, Dresden, Karlsruhe, Los Alamos, and Tokai (Japan). Funding for these comes from various sources, including the European Community and the NSF. This group of new networks are now self-sustaining, precisely in accord with the ICAM goal of nurturing new collaborations in complex matter which then become financially independent of ICAM, while retaining scientific connections.

- An NSF proposal on Frustrated Magnets that brings together physicists and chemists from three countries (Peter Schiffer (Penn State), Gabriel Aeppli, Steve Bramwell, and Andrew Wills (University College, London), Robert Cava (Princeton), and Phillipe Mendels (University of Paris) that arose out of the 2002 ICAM workshop on “Frustrated States of Matter”
- A growing international research collaboration on a new approach to heavy electron materials that makes it possible to pinpoint the development of itinerant behavior originating in the interaction between localized f-electron sites. It developed as a result of the 2003 ICAM workshop on “1-1-5 Heavy Electron Superconductors” and now involves scientists at Los Alamos, Kyoto, the FSU NHFML, Dresden, Iowa State, Rutgers, UC Davis, and Karlsruhe.

3. International research collaborations

I²CAM International Materials Collaborations

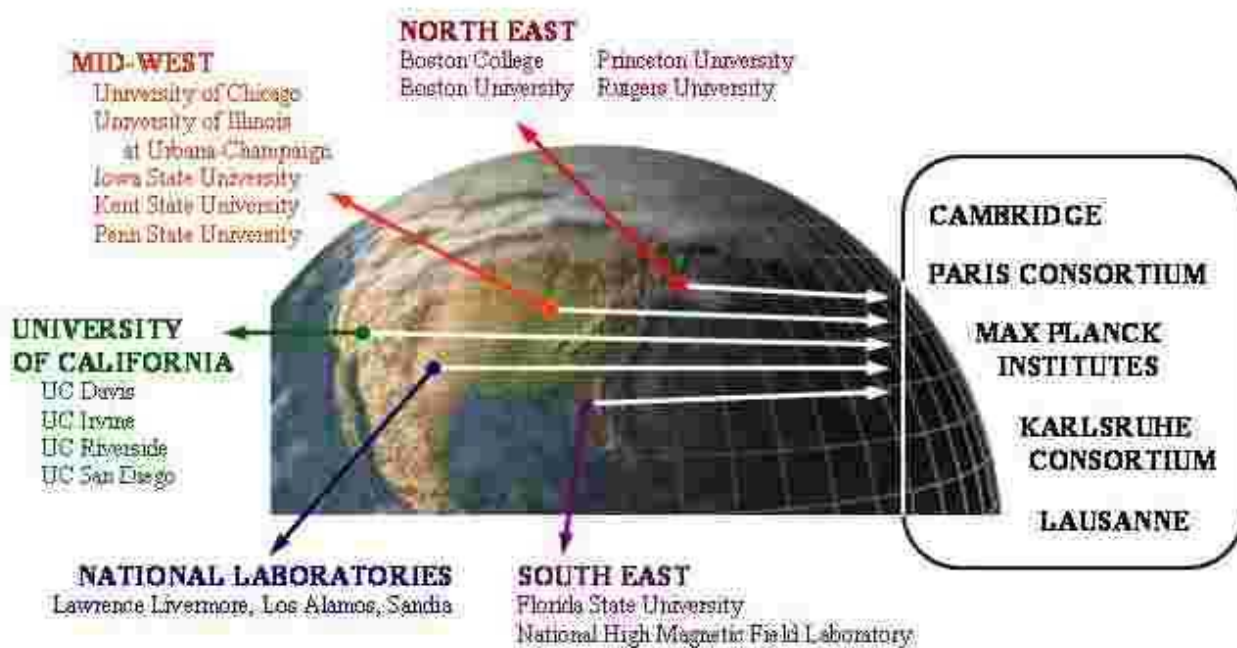


FIG. 1: I²CAM INTERNATIONAL COLLABORATIONS

I²CAM will build on existing US/European collaborative projects at I²CAM branches on frontier topics in complex adaptive matter and take an open, bottom-up, approach to identifying new collaborative programs through jointly-organized US-European Exploratory Workshops (see Sec.9) that are carefully designed to catalyze new research directions and new research collaborations and to encourage the formation of informal research networks. To ensure participation by the broad

international materials community in this program, each workshop will be broadly advertised, while suggestions for new workshops will be sought on a regular basis. In addition, **I²CAM** will follow closely the results of the ICAM US-based Exploratory Workshops, seek advice from the ICAM Science Steering Committee on areas for significant innovative research, and use the ICAM/ **I²CAM** Annual Conference as a forum for discussion of new grand challenges in complex adaptive matter.

I²CAM will put in place two specific mechanisms designed to nurture and expand substantive long-term international collaborations between research groups in the academic and government laboratories that make up its US and European branches:

- An ICAM Fellow Program that will each year enable 50-80 US graduate students and postdoctoral fellows to initiate and conduct collaborative research projects at ICAM's fifteen leading European centers of excellence in materials research for a period of two months to a year, and some 12-20 European postdoctoral fellows from these centers to conduct similar collaborative research at their US counterparts
- Research Travel Awards each year to some 40 especially promising junior and senior materials scientists for short-term visits to nurture ongoing US/European collaborative projects at **I²CAM** branches on frontier topics in complex adaptive matter.

As described in Sec. 6, the programs will be used to strengthen existing research collaborations between groups in US and European institutions that are part of **I²CAM** (depicted symbolically in Figure 1), while making it possible to add new branches and affiliates and to initiate new collaborations that arise out of exploratory workshops, summer schools, or conferences in response to an **I²CAM** call for proposals.

Leaders at each of the sixteen institutions that make up **I²CAM**'s European branches and affiliates have pledged to work with **I²CAM** in organizing joint programs of European Exploratory Workshops and Summer Schools. Graduate and Postdoctoral Fellows, and Research Collaborations. They are:

Cambridge University: Peter Littlewood, Tom Duke, and Gil Lonzarich, Cavendish Laboratory,
Chris Dobson, and Dennis Bray

Dresden: Yuri Grin and Frank Steglich, MPI for Chemical Physics of Solids
Peter Fulde and Frank Julicher, MPI for Complex Systems Research
Joe Howard, MPI for Cellular Biology
Joerg Fink and Jurgen Haase, Institute for Solid State and Materials
Research

Erice: Giorgio Benedek, Director, The International School of Solid State Physics of the E. Majorana Foundation and Centre for Scientific Culture

Karlsruhe: Hilbert von Loehneysen and Peter Woelfle, Institute for Solid State Physics, Institute for Nanotechnology, Institute for the Theory of Condensed Matter, Physics Institute

Lausanne: Lazlo Forro and Davor Pavuna, Institute for the Physics of
Complex Matter, Horst Vogel

Paris: Henri Alloul, Universite de Paris Sud (Orsay)

Antoine Georges, Ecole Polytechnique
Jean-Francois Joanny, Institute Curie
David Bensimon and Roderick Moessner, Ecole Normale Supérieure
Catherine Pepin, CEA, Saclay

4. Research Opportunities

Foreign collaboration has played an important role in the progress of materials science for most of its existence as a discipline. The European and US disciplines have numerous differences of approach and even underlying philosophy of approach that offer a strong rationale for serious and close international collaborations in the formation of research approaches with true hybrid vigor.

Although **I²CAM** will begin with the considerable roster of European leading materials researchers in the fields of quantum electronic and living matter listed above, supplemented by their counterparts at its seventeen US branches, and including those who have agreed to organize the workshops described in Sec. 9, and/or serve on the ICAM Governing Boards, the ICAM Board of Governors and the ICAM Science Steering Committee, it can and will do much more to involve leaders in materials research in its activities. We propose within **I²CAM** to

- Identify workshop themes and organizers who will use their workshops to bring important new perspectives and researchers into the **I²CAM** community
- Consider organizing an Annual Symposium on Frontiers in Emergent Matter, that would alternate between the US and Europe and bring sixty to eighty leading researchers together for three days to discuss grand challenges in the study of emergent behavior in matter. A number of **I²CAM** leaders plan to participate in an ICAM Symposium on Frontiers in Correlated Matter that will take place from Aug.5-8, 2004, and will use that opportunity to interest their distinguished international colleagues who are not yet members of the **I²CAM** community in becoming part of **I²CAM** and to discuss how such a continuing series of Symposia might best be organized.
- Organize regular symposia on emergent behavior in matter at meetings of the Materials Research Society, American Physical Society, American Chemical Society, AAAS, and the European Physical Society that bring the scientific focus and activities of **I²CAM** to the attention of a wide audience
- Invite leading materials researchers not yet affiliated with **I²CAM** to speak on the topic of “Grand Challenges in Materials Science” at the ICAM/ **I²CAM** Annual Conference. This will accomplish two goals: expanding the number of key participants in our community and stimulating a discussion of significant research themes to be addressed in **I²CAM**’s research

Much of the discussion at the November, 2003 meeting of the ICAM Science Steering Committee (SSC) and the 2003 ICAM Annual Conference that followed was focused on planning the form and content of **I²CAM**. Exploratory workshops that might lead to substantive research themes for **I²CAM** were discussed by the SSC which provided input to the four workshops described in Sec.9. Several sessions of the Annual Conference were devoted to grand challenges in complex adaptive matter, and out of these talks and discussions a number of candidate research themes to be addressed by **I²CAM** emerged. Among these were the development of new techniques that will enable theorists to treat on an equal footing local (small groups of atoms in clusters) and global behavior, the prevalence of intrinsically inhomogeneous electron behavior (dubbed “quantum mayonnaise” or “soft electronic matter”) in correlated electron materials, and the possible applicability of techniques borrowed from quantum matter to the understanding of cellular behavior (“Stochastic Cell Biology”). Two broad research themes for **I²CAM** emerged: one in materials science focused on the design of new materials; a second in biological physics on fundamental questions in living matter to which **I²CAM** might be in a unique position to contribute. We discuss these briefly here.

We are at an interesting and enviable time in condensed matter research. The ability to characterize materials routinely in great detail is unprecedented. Yet the rapidly enlarging data base has not in the case of materials driven research been accompanied by what one might call revolutionary new insights into how materials work. We are good at providing *ex post facto* explanations for the properties of materials, while having almost no ability to predict anything interesting. The field of artificially structured materials does have some success in making materials with desired properties, but what is of interest in the domain of new materials is pushing response functions into new territory and the discovery of new physical phenomena. One has only to look at the history of superconducting materials to see how little we understand a priori when it comes to actual materials: quite apart from the unexpected propinquity of magnetic and superconducting behavior, we have the recent startling finding of 40K superconductivity in MgB_2 which is now understood as coming from an idiosyncratic band structure. We can ask ``where was this hiding?'' in all the prior theoretical work on superconducting materials. More to the point, where can we look for more of the same?

It seems that we need new approaches to understanding materials. It is significant that solid state chemists and condensed matter physicists whose interest is new materials approach the subject from opposite directions: where the interests of solid state chemists terminate, that of the condensed matter physicists begins, and this is at the boundary between structure and properties. Chemists and physicists think differently and they use different languages. **I²CAM** can provide the enabling setting for exploring new unifying themes of approach to materials driven science by taking full advantage of the quite different pockets of expertise of very disparate intellectual tradition. More people working along similar lines will not provide the new materials science, rather new unifying organizing principles in materials science developed from the assimilation of different intellectual traditions across international borders have a chance to succeed.

Living matter is of course is the ultimate complex and self-adapting form of matter, and we face two major questions: (1) Will we see new physics emerging from the complexity of the biological molecules and organisms, that is, will we observe emergent properties of collective dynamics arise in biomolecules and biological systems that one could scarcely predict? For example, data on the organization of gene regulation networks that represent complex interactions amongst nucleic acid and proteins are currently being represented in the form of circuit diagrams which suggests the possibility that they are fully deterministic and that spatial aspects of the problem are irrelevant. This overlooks the presumed diffusive location of genes by proteins and the inherent stochasticity associated with the single genome and small absolute numbers of proteins involved in regulation. The system may turn out to be deterministic, but it may present more interesting emergent phenomena; at this point, we simply don't know which way nature has really gone. (2) Will the insights gained from application of physics principles to complex biological systems result in as tremendous an impact on biology and the life science as it has had on electronic technologies? As an example, the zeolites built up from silica and alumina tetrahedra present a remarkable range of three dimensional structures. Is there any sense in which the energy landscapes that can be sampled calorimetrically for these materials can be related to the landscape paradigms emerging from protein folding in biology? This question is, in fact, at the core of an upcoming ICAM workshop.

These are tremendous challenges, and a new generation of cross-disciplinary scientists must be trained to attack them. **I²CAM** can act as a principle international conduit for this pan-national fertilization between condensed matter physics and the life sciences, since it has an unmatched intellectual cross-disciplinary infrastructure of physicists and biologists already in place and ICAM, its parent institution, has already sponsored a number of workshops on the physics of biological systems. **I²CAM** is thus poised to be the primary link between the United States and Europe in

developing the crucial link between physicists who study complex emergent matter and the next generation of scientists who attack these grand challenges.

In networking with other IMI's, universities, centers, and national facilities on these and related questions, **I²CAM** will first-of all make full use of the ICAM network that already links thirty-six leading research institutions in this country and Europe. We further intend to use the Exploratory Workshops, the ICAM/ **I²CAM** Annual Conference, and the proposed Frontiers Symposia as a way of establishing further contacts and expanding our network potential.

5. Education and training

Training of Graduate Students and Postdoctoral Fellows.

The scientist who has worked in the US and overseas is immediately conscious of the strikingly different, yet often complementary areas of expertise, philosophy and approach present in different research communities. To work in a new community is to open the mind in ways that cannot be achieved by regular graduate programs. Indeed, materials scientists who have grown up in communities inside and outside the US have gained immensely from this exposure to new scientific method and philosophy- both experimental and theoretical - and have frequently gone on to become leaders of the field in their respective countries.

In a modest yet ambitious way, the **I²CAM** Exchange, Workshop, and Summer School Program endeavors to seed a new generation of internationally educated students, both graduate and post-doctoral, who grow scientifically through their **I²CAM** research experience. **I²CAM** will be able to leverage NSF funds for education in ways that a more conventional postdoctoral program cannot achieve. **I²CAM** grad students and postdocs will be for a brief and privileged period, citizens of two systems. This is an unrivaled experience. The benefits will accrue through:

- Contacts made at **I²CAM** workshops and the proposed summer school. **I²CAM** is committed to a strong level of participation of graduate students and postdoctoral fellows at its workshops. These can provide the core links on which later international collaborations are built.
- Direct collaboration between **I²CAM** nodes. There is no substitute for the experience, new stimulus and insight that overseas research, even for brief periods of time, can achieve.
- People skills. In many cases, the post-doc or grad student going to an international node will be the key "vector" of research, ideas and techniques between two **I²CAM** nodes, an experience that will foster growth of scientific perspective, communication and people skills.

Summer School

Each year **I²CAM** will organize a joint US/European Summer School of two-four weeks duration on a frontier topic in complex adaptive matter. It will provide approximately half the total cost of the school in the form of travel support to enable some 40 US graduate students, postdocs, and lecturers to participate; the remaining costs of the school would be provided by its European organizers and the school host. The organizers and topic will be selected by the ICAM Science Steering Committee following an annual call for proposals.; the selection criteria will be scientific merit and timeliness; quality and experience of proposed lecturers; mechanisms proposed to ensure broad student participation; organizational experience, and proposed infrastructure. The school will be held in

Europe in Erice, Cargese, Dresden, or other location that has demonstrated it possesses an effective infrastructure for summer school support. Once a proposal has been approved, the choice of speakers and participants will be made by the School organizers.

Curriculum development

Developments in materials science are proceeding at such a rapid pace that academic institutions find it difficult to provide an up-to-date-curriculum for their undergraduate and graduate students. **I²CAM** can help in at least two ways: by providing a library of pedagogical materials dealing with emergent behavior in matter that are taken from popular talks and lectures given at branch member institutions or at ICAM or **I²CAM** workshops and summer schools; and establishing a web site devoted to curriculum reform that will make it easy for faculty designing new courses to exchange views. For example, a UCR faculty committee is working on establishing a curriculum that would include biological and nanomaterials (carbon nanotubes, in particular), with a special emphasis on interfacing biological materials with carbon and silicon. Through the proposed web site it would be able to establishing links between its local endeavors and those of the international community, and possibly bring a group of international experts together to build upon and integrate these local efforts.

International Scholars Programs

I²CAM will consider supporting the expansion or initiation of University programs that provide opportunities for international undergraduate, graduate, and professional students who would like to obtain hands-on experience in biological/physical sciences laboratories. A UC Riverside pilot program, directed by Prof. V. Parpura, offers an 8-week summer laboratory rotation that has proved quite successful in placing international students in laboratories in the UCR Departments of Cell Biology and Neuroscience, where their research has led to publishable results, and to the initiation of new collaborations. Another program for which **I²CAM** will consider providing an international component is the educational program of the Center for Theoretical Biological Physics at UCSD that serves as a training ground for scientists with previous experience in condensed matter, non-linear science, and statistical physics to move toward biological physics.

It is perhaps the training and educational program of **I²CAM** that will have the longest lasting impact. Indeed, if we are successful, this effort will provide a seed for a new generation of condensed matter and biological physicists - a new young community with strong international links overseas, a substantive breadth of experience and approaches, and a strong sense of the purpose and pioneering challenge of their chosen field.

Educational and Public Outreach

In the public eye, materials research is more commonly associated with the structural aspects of materials, such as cracks, micro-structure, composites, alloys or plastics than with cutting-edge topics involving emergent behavior in matter. Few high school students, undergraduates, or members of the public learn that materials ranging from the coldest quantum matter, to soft matter and glasses, to living matter, display unexpected collective emergent properties and that the search for the organizing principles responsible for this behavior is one of the grandest scientific challenges of this new century. Part of the educational mission of ICAM is to share this story, and to convey to the high school student and the general public the excitement as well as the challenge of understanding emergent behavior in materials

In its activities to date, ICAM has vigorously promoted the idea that science research needs to be carried out hand-in-hand with science outreach. This is not a new idea, but one that goes back to many

venerable European institutions such as the Royal Institution in London, (where Davy and Faraday implemented the notion of Friday public talks that continue today) or the College de France (where research physicists to this day present public lectures as part of their regular activities). Through its Emergent Matter Project, ICAM, as a modern-day institute without walls, has pursued the same goals. **I²CAM** provides an outstanding opportunity to build upon the initial steps taken by ICAM, not only extending the idea of outreach to our international colleagues, but drawing on their particular expertise in these areas. In particular, **I²CAM** will:

- Continue to promote vigorously the idea of outreach at its workshops. At our various nodes in Europe there is considerable expertise in the area of public lectures and demonstrations on which we will build
- Through its European nodes, endeavor to make new contacts with the substantial expertise in popular science writing and reporting in Europe- journals such as Physics World, New Scientist, la Recherche, Physik in unserer Zeit, as well as several leading newspapers have active science writing staff. **I²CAM** will continue a tradition ICAM has begun in North America, and encourage participation by science writers in workshops and symposia as part of their outreach components.
- Encourage its postdocs (and their mentors) to develop an outreach component of their research- through a web-site, a popular article or a public lecture or school visit.
- Work in collaboration with ICAM and professional societies and museum professionals to establish a special web site—a virtual “museum” devoted to emergent behavior in matter -- that is aimed at K-12 and that brings out the international character of research in this field. Over time, given sufficient additional Foundation and governmental support, this would evolve into a physical exhibit that travels throughout the US and Europe and serves to enhance appreciably the pool of young people who will, over time, become members of the international materials science community.

6. Exchange programs

A key component of the Institute is the development of mechanisms for US graduate students and postdoctoral fellows to acquire an international perspective on frontier topics in the study of matter at an early stage in their careers, and so enter the cutting-edge international materials research community. We will introduce four linked programs to facilitate this exchange:

- **I²CAM Postdoctoral and Graduate Fellowships**— a fellowship program for students and postdoctoral fellows to spend a period of two months to a year initiating and conducting collaborative research in an international laboratory
- **Research Travel Awards** for junior and a few senior materials scientists who wish to make short term visits to nurture ongoing collaborative research activities between **I²CAM** branches
- **Exploratory Workshops**, a program of cutting-edge workshops in Europe designed to catalyze new research directions and collaborations that will have a significant US component made possible by **I²CAM** support
- **Educational Travel Awards** for students and postdocs to attend other European workshops and summer schools.

These exchange programs have more than just a simple educational goal, however important that is. They are aimed further at building an international community to forge the interdisciplinary agenda of I²CAM. The exchange program is itself the bridge between the disparate research strengths in different countries, and between the different national schools that bring diversity to the study of materials.

The joint US/European I²CAM Graduate Fellow and Postdoctoral Fellow Program will enable up to 80 US graduate students and postdoctoral fellows annually to spend from two to twelve months abroad initiating and conducting collaborative research at a leading European center of excellence in materials research, while bringing to the US up to 20 postdoctoral fellows from these centers to carry out research at their US counterparts.

These fellowships will be awarded on a competitive basis and will be science-driven. Their goal is to broaden the training of junior scientists by exposure to new topics and ideas, to provide access to materials, projects and equipment not available at the home institution, and to cement working partnerships between the international teams.

The fellowships will be internationally advertised, and we will accept applications both from individuals (prospective fellows) and collaborating institutes (prospective projects). We thus satisfy a training mission while maintaining a bottom-up research-driven agenda that reflects the interdisciplinary focus of the institute. In order to have speed and flexibility, the fellowship competition will be run quarterly; awards will be made by a joint US/European Committee of Selection, reporting to the Management Committee described in Sec.11. Fellows will continue to receive their usual stipends from their home institution. The supplemental funds provided by the Fellowship will go directly to individual Fellows to support their travel and living costs. Mentors at the host institutions will provide a research infrastructure, support, and guidance on the same terms as their own students and postdocs.

We will develop an on-line web driven application process. There will be two modes for fellowship applications:

1. *Student/Postdoc Proposed:* In this mode, the graduate student or postdoc will identify the research opportunity, and write a brief proposal to the fellowship committee with a short budget justification. We will give preference to this mode overall, expecting about 2/3-3/4 of the fellowships to follow this route. Our intent is to inculcate scientific independence and maturity in the students.
2. *Mentor Proposed:* In this mode, which will be considered on a once annual basis each Fall, mentors from each of the two institutions will propose a project that can be fulfilled by a postdoc. Evaluation will be based upon the scientific quality of the proposal, with trust that the mentors will succeed in identifying a suitable candidate.

In each mode of application, the primary criteria for evaluation, in priority order, will be: (1) scientific merit, (2) evidence of promise for the fellowship serving to nurture a long-term international collaboration and (3) interdisciplinary bridging. That is, the Fellow must be carrying out research that simply would not have likely occurred otherwise, and that will help nurture a significant long-term international collaboration on a frontier scientific topic in complex adaptive matter, one that will preferably bridge disciplines.

Given the ambition of **I²CAM** to affect such a large cross section of materials science and biology in this country (e.g., consider the number of student fellowships and travel awards we are proposing), if the number of proposals becomes large we will ask local ICAM branches to first screen proposals to a manageable number (3-5 per branch) subject to the above criteria.

A program of **Research Travel Awards** will provide a minimum of 80 travel stipends annually to especially promising junior and senior materials scientists to nurture US/European collaborative projects on frontier topics and to bring leading European scientists to the US to participate in ongoing **I²CAM** Exploratory Workshops that have a minimum of 20% participation by US graduate students and postdoctoral fellows. These awards are to facilitate existing and emerging collaborations, for example by facilitating experiments in a host institution's laboratories by a visiting researcher, to develop new collaborative projects, and to disseminate recent results. Awards to seed research collaborations can be applied for on a rolling basis and will be evaluated by the ICAM Committee of Selection using the criteria listed above for Fellows. We will maintain a web-based application procedure and make use of internet and email communication between the committee members so that response times can be fast.

Five **Exploratory Workshops** designed to identify new research directions and catalyze collaborative research will be supported each year. As described in Sec. 9, proposals to organize such workshops will be accepted on a rolling basis and evaluated by the ICAM Science Steering Committee. A web-based proposal submission procedure together with use of the internet and email communication between committee members will make possible a rapid response time, so that the over-all time between proposal submission and implementation can be as short as six months. **I²CAM** will provide support for participation by 24 US graduate students, postdoctoral fellows and lecturers in each workshop; their selection will be made by the Workshop organizers, using criteria similar to those described above for Fellow selection.

A program of **Education Travel Awards** will provide a minimum of 80 travel stipends annually to enable US graduate students and postdoctoral Fellows to participate in additional European Exploratory Workshops devoted to frontier topics in materials research. Applications for these awards may be made on a rolling basis, and will be evaluated by a sub-committee of the Management Committee, as described below. Student travel awards will be awarded on an as needed basis subject only to a justification for conference attendance based upon giving a presentation (poster or talk) or research related to the establishment of a possible long-term research collaboration.. These will be examined and approved by the chair of the management committee in a timely manner.

We stress that according to our principles of running an open and delocalized Institute, branch membership in **I²CAM** is available to any qualified institution, while the fellowships and travel awards will be open to any US graduate student or postdoctoral fellow at branch member institutions.

7. Partnerships

I²CAM will work closely with scientists at the national laboratories that are ICAM branches- Livermore, Los Alamos, and Sandia- on the implementation of all aspects of its programs. In particular, we will always seek to jointly carry out workshops and meetings when the mutual interest is high; this is the case in fact with the aforementioned workshop on landscape paradigms in materials. When our workshops contain sufficient biological content of interest to the health

community, we will seek partnerships with the NIH and its various centers; for example, in the recently completed ICAM workshop on functional magnetic resonance imaging, the NIH National Center for Research Resources on Magnetic Resonance Imaging at the University of Florida contributed. We also have a model of how to involve significant industrial participation in our workshops from our "Rational Drug Design" workshop held in San Diego in Summer 2001. Where possible, in a time of severely constrained state budgets, we will seek partnerships in supporting workshops and outreach. In particular, in California, the UC Biotechnology Program contributed \$15K towards the "Physical Principles of Amyloid Diseases" ICAM workshop in San Francisco in 2001. The UC system also has numerous programs aimed at outreach in science towards less represented groups (If funded, **I²CAM** intends to explore the possibility of partnering on its educational, training, and outreach programs with private Foundations such as Lounsbery, Packard, and Sloan (who have previously supported ICAM), and with the Moore and Gates Foundations. Finally, in concert with European partners, **I²CAM will seek support from the European Union and NATO.**

8. Internet resources

As an institute without walls spread between over twenty research institutions of disparate geographic and structural character, one of the great challenges for **I²CAM** will be to maintain vitality and connectivity. Much of this will be ensured through the fellowships, travel awards, workshops and summer schools proposed here, but on a day-to-day basis connectivity will obviously have to be maintained through the internet, which is of course a primary means of operation for young scientists. Accordingly, active support for **I²CAM** web pages is of fundamental importance to our operations. The site will be established and maintained at the Davis campus. We are budgeting for a .5 FTE internet professional to oversee the construction and maintenance of these web pages, with additional annual funds for computer and software upgrades. We envision that in developing our web based systems the key components will be as follows:

- ***I²CAM Science Pages:*** **I²CAM** will maintain pages with pdf file versions of all presentations at **I²CAM** conferences or summer schools. In addition, **I²CAM** will solicit pdf copies of all relevant seminars and course notes from branch members, and will develop and provide software to facilitate this at the branches. Seminars from branches will be posted in advance in the **I²CAM** calendar so that webcast or teleconference feeds might be possible. These pages will be open and advertised to the materials community at large. This service has been carried out very effectively and impressively within the somewhat narrower scientific and geographic confines of the Kavli Institute for Theoretical Physics at UC Santa Barbara. The challenge for **I²CAM** in this regard will be to create a culture and infrastructure for such web based science pages on a truly global scale. In this sense, we seek something similar to the International Virtual Institute (IVI) on Nanotechnology, although the **I²CAM** web pages will be broader in scope and function than the IVI, and will serve very much as the practical glue of our institute. We believe this will be a very important scientific and educational service to the international materials community provided by **I²CAM**.
- ***Up to date listing of I²CAM senior scientists and research interests:*** For all scientists considering applying for fellowships, travel awards, or collaboration seeding, it will be crucial to maintain an up to date listing of participating senior scientists along with their current research interests and laboratory capabilities. The **I²CAM** front office will actively solicit updates to this list on twice yearly basis, and each web page listing will link directly to the web page of the home researchers.

- ***I²CAM Virtual Journal Club:*** The idea here is to maintain an online journal club file where young scientists work through the details of interesting papers, presumably presented locally to their research groups and peers, and then post their lecture notes on the **I²CAM** web pages. Here, the access would be limited to **I²CAM** participants who had signed up to the journal club service.
- ***I²CAM Calendar:*** A calendar, updated monthly, of upcoming international workshops and conferences on materials science, correlated matter, and biological physics that might be of interest to the international materials community. It might have separate listings for **I²CAM** events and non- **I²CAM** events. For each event, it would include links to the conference or workshop web site. It would also contain links to web sites at branch member institutions that contain comparable information for that institution.
- ***Quarterly I²CAM newsletter/progress report:*** This will contain information supplied by members of the **I²CAM** community that might be of interest to other members, such as preprints and publications based on participation in **I²CAM** events, reports on honors and prizes won, the annual reports by ICAM Graduate and Postdoctoral Fellows, overviews of **I²CAM** workshop prepared by the organizers.
- ***Web based conferencing:*** To maintain regular communication between the **I²CAM** Management Committee and its European counterparts for monthly meetings, and to facilitate workshop/summer school organizing. We hope that this facility if developed well might also be used in promoting scientific collaborations.
- ***I²CAM ``Classifieds``:*** Not all of the **I²CAM** activities will need to take place from person-to-person contact. Inspired by community building web sites such as craigslist.org, **I²CAM** will develop its own ``classified`` pages in which potential collaboration offers may be proffered or requested, or equipment needs or capabilities advertised, for example. Like the civil society counterpart, we may suppose that left to its own devices, the **I²CAM** community will devise unforeseen categories for interaction. These classifieds will also, of course, contain information about job opportunities for junior scientists.
- ***Materials network links:*** The web page oversight committee (see the discussion of management below) will continually update links to important international materials science and biological science networks.

9. **I²CAM International Exploratory Workshops**

We propose to organize in Europe each year a minimum of five **I²CAM** Exploratory Workshops of four to five days in duration on topics at the frontiers of the search for the organizing principles responsible for emergent behavior in materials. In so doing, we intend to build upon the guidelines and procedures that ICAM has developed for its highly successful US Exploratory Workshop program. Thus **I²CAM** workshops will typically involve from twenty-five to forty participants drawn from a broad range of disciplines and institutions, with more than half the participants attending an **I²CAM** workshop for the first time as representatives of non-ICAM institutions. **I²CAM** workshops will be unique in that the lead time from proposal to implementation can be quite short (as little as six months), while at each workshop there will be as much time allotted for discussion as for presentations.

I²CAM workshops on cutting-edge topics in the study of matter will be carefully designed to:

- introduce young US materials scientists to leading members of the European materials research community
- build bridges between disciplines

- build bridges between leading research groups in US and European institutions
- catalyze new research directions
- stimulate follow-up activities, such as new inter-institutional and transdisciplinary research collaborations, and, in some cases, new informal research networks
- insure participation by graduate students, postdocs, and under-represented groups.

Workshop proposals will be sought year-round from the international scientific community. Following an electronic review of the proposal by the **ICAM** Science Steering Committee for its content, timeliness, and breadth of participation, **I²CAM** will provide approved workshops with organizational assistance and up to \$30k in support of travel and housing costs for US junior participants and speakers. A comparable sum will be pledged by its European partners in support of European participants and workshop infrastructure costs.

A web site that lists the workshop objectives and program and contains an application form for interested participants will be established for each workshop. Following the workshop, organizers and speakers are requested to use this site to insure that workshop results are communicated rapidly to the scientific community through posting of workshop talks and an overview written for a general scientific audience.

I²CAM's European partners will be responsible for the local arrangements for each workshop. They bring to this task a wealth of experience in organizing successful workshops at Cambridge, Cargese, Dresden, and Schloss Ringberg (Tegernsee) and have promised the availability of these and other sites for **I²CAM** workshop programs in 2005 and beyond.

Three proposed European Exploratory Workshops that have reviewed by the ICAM SSC and one that is currently under review are described below as examples of ICAM's "cutting edge" materials science.

1. Chemical Physics of Complex Adaptive Matter

Organizing Committee: Y. Grin, F. Steglich, and S. Paschen, Dresden, K. A. Mueller, Zurich, Z. Fisk and S. Kauzlarich (Davis), P. Attfield, (Edinburgh), P Canfield and G. Miller (Ames). Among the invited speakers will be R. Hoffmann and F. di Salvo (Cornell) C. Lieber (Harvard), D. Vollhardt (Aachen), B. Raveu (Caen)

A major question for materials scientists engaged in the design of new materials is: to what extent can one predict behavior given chemical composition and structure? Solid state chemists and condensed matter physicists approach the question from opposite directions: where the interests of solid state chemists terminate, that of the condensed matter physicists begins--at the boundary between structure and properties. The workshop is intended to bring these two communities together and take full advantage of the quite different pockets of expertise of the very disparate intellectual traditions of Europe and the US in the development of new materials.

2. Correlated Thermoelectric Materials

Organizing committee: V. Zlatić, E. Bauer, M.B. Maple, M. Kanatzidis, P. Rogl, J.K. Freericks, Francis Hellman, Albert Migliori, Brian Sayles, Sriram Shastry, Art Ramirez)

Correlated electron systems close to the metal-insulator boundary (Kondo insulators, correlated semiconductors, skutterudites, and related heterostructures) offer great potential for building thermoelectric devices useful at low temperatures. From the complexity of the problem it is clear

that the engineering of such devices cannot be successful without input from fundamental research. One has to solve the chemical and metallurgical problems to produce new materials, one needs accurate characterization of the physical properties of these highly complex chemical structures in order to understand the systematic trends, and one has to perform theoretical modeling of various quantum mechanical effects in strongly correlated systems. Success is only likely to be achieved through a combination of techniques in a multi-front approach and the workshop will provide an opportunity for experimentalists- chemists, metallurgists, physicists—and theorists to step back and look at the bigger picture. The aim of the workshop is not so much to offer the 'present day solution' of various anomalies observed in correlated thermoelectrics but, rather, to characterize and describe the data, so as to find a common element in the experimental results.

3. Cell mechanics and Cellular Mechanosensation

Organizers: F.Julicher, MPI for Complex Systems Research and J. Howard, MPI for Molecular Cell Biology and Genetics, Dresden

Many active cellular processes such as cell motility, mitosis but also the formation of larger cellular structures during development, involve the dynamic organization of the cytoskeleton. The mechanical properties of cells are important in all these phenomena and mechanically active processes which generate motion and forces play a key role. In addition, cells react to externally imposed mechanical conditions and can act as force sensors. Forces are transduced by focal adhesion points. Many highly specialized cells possess mechanoreceptive elements. These are complex cytoskeletal structures that undergo mechanical deformations and trigger the opening of mechanosensitive ion channels. An example is the hair bundle of the sensory cells in the ears of vertebrates that are at the same time sensors and active amplifiers. The proposed workshop intends to bring together leading scientists from physics, biophysics, developmental biology, cell biology and sensory neurosciences to discuss recent developments in this important field.

4. The Frontiers of Assembly in Materials: Organizing Complex Functional Behaviors in Matter.

Organizing Committee: R. Nuzzo (UIUC), G. Whitesides (Harvard U.), C. Bain (Oxford U.), M. Grunze (Universität Heidelberg)

The ability to derive function from a hierarchy of structure finds no better exemplars than that provide by living systems. Biological systems organize composite architectures of exceptional complexity. These in turn mediate complex couplings of non-linear systems of chemical reactions, maintaining regulation and feedback, that serve to sustain cells and ultimately allow them to adapt, evolve, and self-replicate. These structures—ones based largely on organizations of organic macromolecules and mesophases—provide the central frameworks that sustain the complex dynamics on which all life is built. The architectures of technology are often inspired by nature but, in comparison, none develop in their own unique ways hierarchies of organization that match those found in biology.

This workshop will explore the current status and opportunities for progress in research on the self-organization of complex structures and functions in both molecular and materials systems. Of particular interest for this workshop will be an examination of the emerging opportunities for developing processes that might serve to bridge the current limitations of self-assembly as a basis for effecting and exploiting complex organizations in condensed matter systems. The development of complexity, using processes that mimic the dissipative processes of biology, are of particular interest

in this regard and will be examined by a panel of scholars with deep records of accomplishment in this field.

10. International Materials Research Network

As a prelude to any activities at the international level promoted by **I²CAM**, **ICAM** has been working with domestic scientific societies to promote the understanding of key issues of emergent matter within the community and to the general public. In particular, at the upcoming AAAS meeting in Feb. 2004 in Seattle, an ICAM related symposium will be presented. **ICAM** has begun discussions with officers of the American Physical Society (Myriam Sarachik) and the Materials Research Society (Alan Hurd) on ways they might work together on education and outreach on the general topic of emergent behavior in matter, and we will also reach out to the American Chemical Society. Notably, we will explore whether local ICAM branches can provide content to the impressive traveling museum show "Strange Matter" developed by the MRS, and whether we can work together with the Ontario Science Museum to create a virtual museum site on "Emergent Behavior in Matter". With strong alliances on the home front, **I²CAM** proposes to work with these partners and with the European Physical Society, European Materials Research Society, and the International Union of Materials Research Society. We also anticipate natural links with the psi-k electronic structure theory network of Europe; the interests of ICAM and **I²CAM** in strongly correlated matter and biomolecules form natural points of connection with this important organization.

Among the specific activities which we will develop to promote the international network are:

- ***Establishment of further I²CAM branches:*** Although we must be careful not to overextend the nascent institute without walls too rapidly, we can recruit new European members to **I²CAM** each year as our profile expands.
- ***I²CAM symposia at major international meetings:*** Analogous to our AAAS symposium above, and planned APS symposia, we will sponsor symposia on topical subjects at the European Physical Society and European Materials Research Society annual meetings. At the start of each such symposium we will advertise the existence and merits of **I²CAM** and seek to recruit potential students, postdoctoral researchers, and further collaborators.
- ***Special journal issues or reviews devoted to hot issues in emergent matter:*** Many of the major society based journals have special issues or brief-review format forums for articles on forefront research. We will seek to have **I²CAM** related journal issues or review articles placed in major journals of the science societies.
- ***Joint sponsorship of workshops and summer schools:*** **I²CAM** will seek out the international societies for joint sponsorship of exploratory workshops and summer schools. A few years down the line, this will be explored as a way to build bridges to our colleagues in other parts of the world, by holding the workshops on their soil. Notably, we would expect to seek these links with South America, Japan, China, and India through the IUMRS.
- ***Joint linkage of web sites:*** We will seek *quid pro quo* linkage of other materials organization web pages with our own. This will publicize the science content service of our web sites to the interested scientists who are members of the various societies.

11. Management

As can be seen from the proposal so far, I^2 CAM represents a new experiment in how to run a large scale scientific program. As a decentralized institute without walls, there are significant advantages in reduced administrative costs, overhead for services, and additional space needs. Most of the administrative needs of I^2 CAM will be handled by participating scientists themselves. However, since I^2 CAM will not have bricks-and-mortar facilities expressly identified with its operation along with an attendant administrative staff and director, it is imperative that I^2 CAM have a governing committee with clearly stated objectives. Moreover, it is imperative that we streamline and automate via web-based tools much of the evaluation and application procedures.

We must also note here, as illustrated by the accompanying chart (Fig. 2), that I^2 CAM will take over the international responsibilities of ICAM and become its international operating arm,

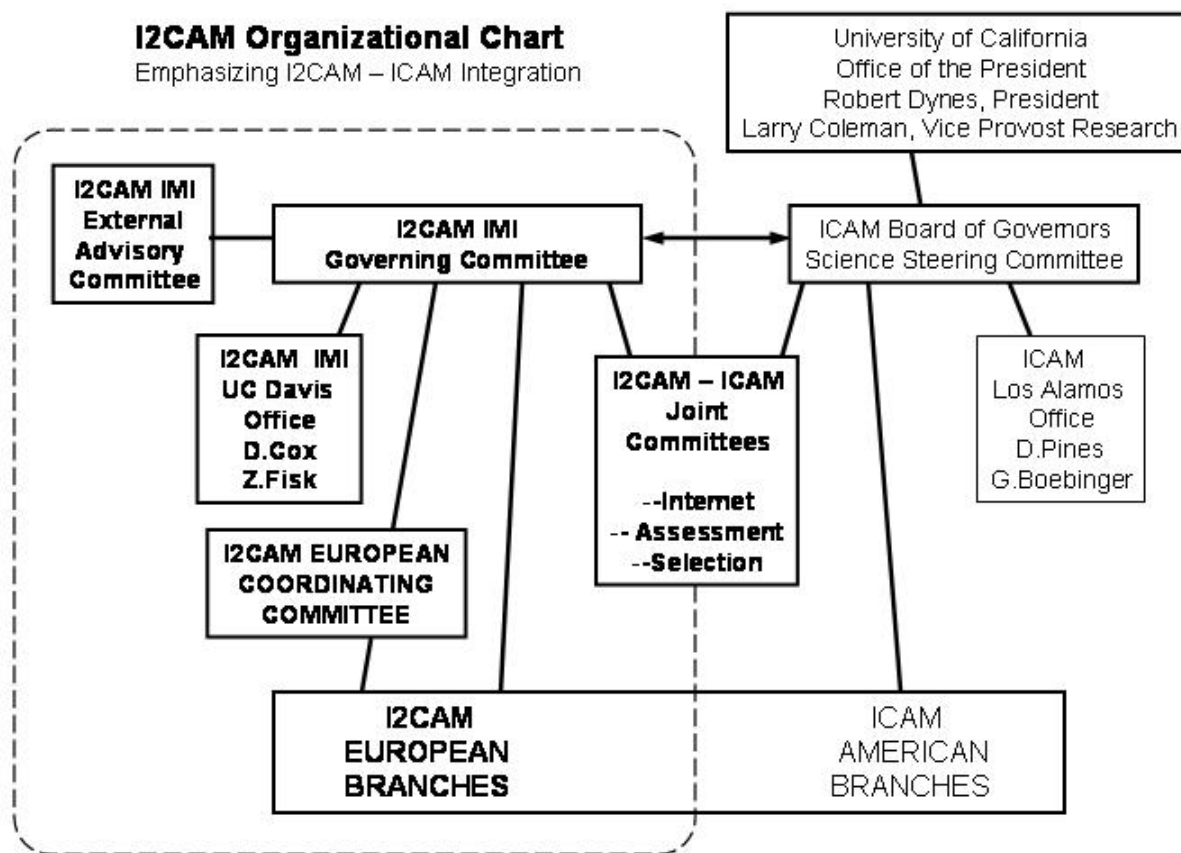


Fig. 2: I^2 CAM Organizational Chart within ICAM. Dashed line indicates boundaries of I^2 CAM

The institutional responsibility for the general finance and management questions of I^2 CAM will rest at UCOP through the office of Vice Provost for Research Lawrence Coleman, whose primary role as co-PI will be to oversee these institutional fiscal and administrative details. ICAM has a five year relationship with the UCOP offices where we have established ICAM accounts, received foundational, university, and federal research support, and have also built a clear and mutual

understanding of the culture and goals of ICAM. This makes for an ideal relationship to administer **I²CAM** through UCOP. In particular, UCOP has bought into and fully understands the distributed nature of ICAM (and by extension, **I²CAM**), and this facilitates the reduced administrative costs that are a crucial (and attractive) aspect of our proposal. We note that although this level of hierarchical structure is essential for ICAM and **I²CAM**, that the primary operations of ICAM and **I²CAM** will be modeled very much after the shared governance structure of the University of California; namely, senior scientists will take ownership responsibility of the key activities via their direct participation in the major committees of ICAM.

The institutional responsibility for science management oversight will rest with the University of California Davis campus where a founding ICAM member and Chair of its Board of Governors, Zachary Fisk, and a longtime participant, Daniel Cox, reside, and be actively implemented through the **I²CAM** management committee described below. As we detail below, we seek funds for one administrative assistant housed at UC Davis.

Management Committee

A fourteen -person Management Committee of leading US and European scientists, with experience on the ICAM Board of Governors and in the design and management of international research networks will direct the **I²CAM** program. It will work closely with the **I²CAM** European Coordinating Committee representing the 15 European institutions that are **I²CAM**'s European branches and affiliates; it will be assisted by a joint US/European Committee of Selection for **I²CAM** Fellows and **I²CAM** Research and Educational Travel Awards, and by the ICAM Science Steering Committee in the selection of **I²CAM** Exploratory Workshops and summer schools. The Management Committee will set leadership directions, oversee all scientific activities of **I²CAM**, encourage outreach and public dissemination of **I²CAM** related science, and ``crack the whip'', so to speak to ensure that the many and disparate **I²CAM** branches actively participate. It will be charged with setting the overall agenda for **I²CAM**, selecting and approving membership of relevant committees, and summarizing and reporting annual **I²CAM** progress to the ICAM Science Steering Committee and Board of Governors, participating institutions, and the NSF.

A Committee of the ICAM Board of Governors will provide internal fiduciary oversight of **I²CAM**'s administrative structure and financial operations while the ICAM Science Steering Committee will act as an Advisory Committee and Internal Board of Review for **I²CAM**'s scientific programs. An External Board of Review, with US and European Co-Chairs from non- **I²CAM** institutions, will meet annually to review and report to NSF on **I²CAM**'s progress.

The proposed makeup of the Management Committee is as follows:

Bob Austin, Princeton University	Zachary Fisk, UC Davis
Greg Boebinger, Los Alamos. ex-officio	Ka Yee C. Lee, University of Chicago
Lawrence Coleman, UCOP, ex-officio	Peter Littlewood, Cambridge University
Piers Coleman, Rutgers University	Jose Onuchic, UC San Diego
Daniel Cox, UC Davis, Chair	David Pines, UIUC and LANL, ex-officio
Laura Greene, U. Ill. Urbana-Champaign	Myriam Sarachik, CUNY
Nina Fedoroff, Penn State University	

This committee will convene twice a year in person in conjunction with already scheduled ICAM meetings and will establish monthly oversight meetings to be conducted via conference call or web

based facilities. Two of the principal tasks each month will be carried out by subcommittees of 3-4 members from the Management Committee. Proposals for student travel awards will be generated and emailed via a web-based system to a subcommittee of three that will provide recommendations on each proposal based upon: (1) Scientific merit, (2) Justification in terms of a travel presentation or quick collaborative effort. A second subcommittee report on **I²CAM** related activities during the past month. Every effort will be made to keep these meetings brief and effective so as not to overload the highly engaged but very busy members of the management committee.

There will be five committees that make decisions about key research issues of **I²CAM**; these will report to the Management Committee but be separate from it in operation, and, as shown in Fig. 2, will play the same roles overall for ICAM that they play for **I²CAM**. Their primary work will be carried out via email, conference calls, and (at least) once a year meetings associated with the Fall ICAM Conference. These committees will have rotating chairs drawn from participating institutions.

ICAM/I²CAM Committees of Selection: The existing ICAM fellowship committee will be expanded and charged with evaluating applications for **I²CAM** Graduate and Postdoctoral Fellowships, while a new Research Collaboration Committee will be established to evaluate applications for ICAM Research Stipends

Exploratory Workshops and Summer Schools: The ICAM SSC has already demonstrated an ability to quickly review and award proposals for high quality cross disciplinary workshops as documented elsewhere in this proposal; they will be charged with this task for **I²CAM**, and asked to evaluate Summer School proposals as well.

Internet communication: This new committee will be responsible for direct oversight and management of the **I²CAM** web pages and web based reporting system, and thus will always contain at least one UC Davis representative. This committee will continually assess the currency of the web pages, make sure that they are functioning properly, and provide updates to the management committee about whether workshops/summer schools are properly posting their talks.

Assessment: This new committee will be assigned to review whether our programs are working, both in terms of the outcomes of specific fellowships, workshops, collaborations, and research awards, and also whether our system is functioning efficiently and effectively. The committee will be charged to develop metrics for effectiveness (e.g., numbers of collaborations and proposals flowing from workshops, number and quality of publications and presentations emerging from fellowships and funded collaborations). Assessment procedures will involve both formative and summative evaluations of all **I²CAM** activities using significant web-based assessment tools. The assessment will be oriented towards the primary goal of **I²CAM**, i.e. to train the future generations of materials scientists in the new approaches to carrying out research at disciplinary boundaries. Some examples of what we plan to do are:

Formative evaluations:

- ***Fellowship expectations assessment*** – All student and postdoctoral fellows will be asked to provide a brief summary of their personal expectations and attitudes for their fellowship before and once during their visit, and will assess how well they met their expectations and how their approach/attitudes to **I²CAM**-style cross institution/cross disciplinary research may have changed. We will use this information in a feedback loop to continually shape and improve the fellowship program.

- *Workshop/summer school expectations assessment* – In a similar fashion, we will query students, postdocs, and a subset of non- **I²CAM** senior participants before, during, and after each workshop and summer school to determine such questions as: what attracted you to the workshop? What activities prior to the workshop would have prepared you well to optimize your learning at the workshop? What could have been done to improve the accessibility and impact of the talks/discussions at the workshop?
- *Impact of **I²CAM** on institutional culture* – We will continually monitor the impacts of **I²CAM** on the cultures of the participating universities and laboratories. If **I²CAM** is having significant or insignificant impact, why? What needs to be done to increase impact on a local scale? This will be done through twice annual web based programs.

Summative evaluations:

- *Qualitative measures of fellowship performance* – By comparing to a control group of non- **I²CAM** students/postdocs carrying out similar research between institutions, we will try to determine what the differences are and what the benefits are of our **I²CAM** program, and how we can maximize the scientific impact of **I²CAM**.
- *Workshop/summer school evaluation* – We will rigorously monitor the number of collaborations, grant applications, papers, and citations to said papers which emerge from our workshops and summer schools. We will also monitor the usage statistics for our posted copies of workshop/school lectures.
- *Traditional Scholarship metrics* – We will summarize papers produced during fellowships both for both number and impact (where are they being published? Are they being read?), along with any invited speaking engagements.

European Coordinating Committee : The 15 European institutions that make up **I²CAM**'s European branches and affiliates will select a nine person **I²CAM** European Coordinating Committee (**I²CAM** ECC) to represent the above fifteen institutions. Its responsibilities will include

- advice on the selection of topics and locations for the **I²CAM** workshops and summer school
- regular consultation with the **I²CAM** Management Committee
- facilitating visits by US participants in exchange programs to near-by institutions

Members of ICAM-Europe have also expressed interest in seeking European funding for research networks that that would work in close cooperation with ICAM and **I²CAM** as the European counterpart of ICAM, and such proposals will be encouraged by the **I²CAM** ECC.